



Forrestal in Flames: Explosions Aboard USS Forrestal

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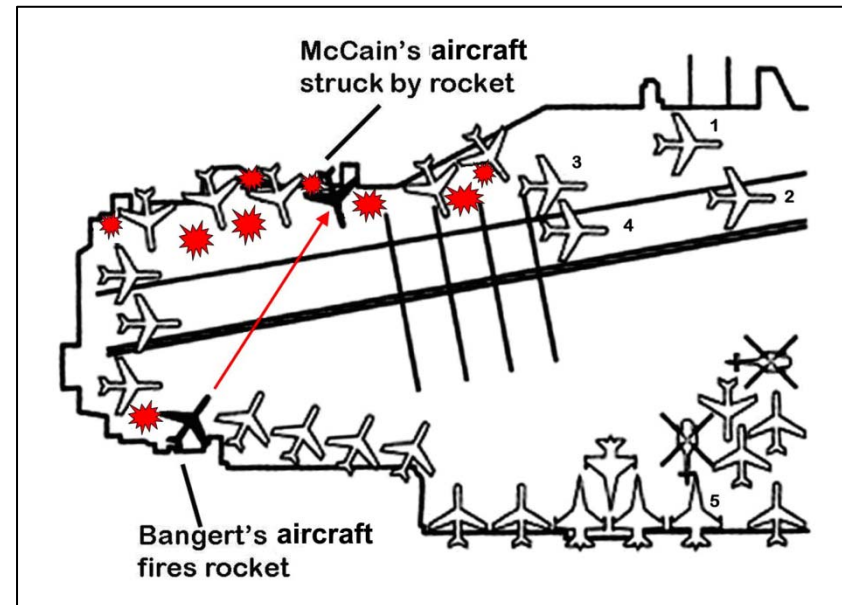
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The Accident

- The morning of July 29, 1967, 27 aircraft assigned to strike targets in Vietnam started pre-flight checks aboard the Navy carrier USS Forrestal in the South China Sea.
- At 10:51:21, F-4 Pilot Jim Bangert hit the power cutover switch (to transition to internal power), and one of his Zuni rockets blazed across the deck, chest high, ripping open a fuel tank of an A-4 Skyhawk, manned by John McCain.
- The fuel ignited beneath an externally mounted 1000 pound B-bomb which, after 1 minute 34 seconds, exploded. The raging fire eventually “cooked off” eight other 1000 pound bombs mounted on other aircraft with horrific effect.



- Before the fires were under control, a total of 134 men were killed and 161 injured. Over 20 aircraft were lost.



Deadly Waivers

- The Zuni rocket launcher was designed with two independent safe and arm systems that prevented electrical signals from the cockpit from reaching the triple ejector rack (TER): a “pigtail” plug and electrical-safety pin (TER-pin).
- Operational procedures stated both were to be inserted and removed (respectively) “just before takeoff,” while the aircraft was positioned on the catapult with a clear field of fire.
- En-route to Vietnam, Forrestal’s Weapons Coordination Board (WCB) approved a waiver to the requirement for insertion of the pigtail connector as a time saving measure – relying solely on the protection of the TER-pin.
- The WCB logic was that this shortcut was acceptable because the TER-pins were in place until launch. The WCB decision was never forwarded to higher authority for review, as required by standard operating procedures.



- Unfortunately, flight maintenance crews, driven by the same need to save time, had, on their own volition, made similar determinations resulting in unauthorized removal of the TER-pin.



Proximate Cause

- Power surge in F-4 Phantom triggered launch of Zuni rocket while Phantom was parked on deck.

Root Causes/Underlying Issues

- Known deficiency in F-4 armament electrical system coupled with Zuni rocket launcher design flaws
 - In his testimony after the catastrophic accident, Captain Beling questioned the intrinsic safety of the Zuni safety and ignition system, asserting that “Forrestal’s ordnance personnel never had a safe system to work with.”
- Combat time pressures resulting in uncoordinated waivers and on-the-fly procedural changes
- Miscommunication of and lack of command line involvement in procedural changes
 - In violation of established risk management protocol, the Captain was never notified of the WCB decision regarding the pigtailed, and first-line supervisors were, at the time, unaware of the unauthorized TER-pin removals implemented by flight maintenance crews.
- Dangerously unstable ordnance
 - Time pressures to support the 1967 air offensive coupled with logistical supply issues resulted in Navy upper management decisions to use obsolete weapons that had been stored in open-air sheds in the Philippines since the end of World War II.
- Insufficient firefighting training and infrastructure
 - Untrained sailors valiantly fought jet-fuel fires with water hoses (the wrong thing to do) rather than foam. Only half the ship’s crew and none of the Air Wing crew had attended firefighting school in the previous three-year period (in spite of repeated requests by the Captain for training slots).



NASA Applicability

- Be vigilant in ensuring that reliance on redundant systems does not lead to misplaced complacency.
- Never remove a safety critical barrier in a high-consequence environment without full understanding of status of remaining controls.
- Operating with one safeguard requires careful deliberation and approval by accountable management at appropriate levels as well as verification that the secondary barrier is, in fact, effective and has been implemented.
- Ensure waivers, and their acceptance rationale, are revisited on a routine basis.



- Design engineers must understand hardware/software electro-mechanical system behavior in off-nominal and transient upset environments.

Forrestal Lesson: Every sailor, a firefighter.
NASA Lesson: Every engineer, a safety engineer.